ENVIRONMENTAL MANAGEMENT PLAN

Peacock Creek Km 7.5 Morice FSR
Nadina Forest District

Rev 1

March 2021

PREPARED FOR:

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Revision Record

Rev	Description	Originator	Checker	Approved	Date
R0	DRAFT ENVIRONMENTAL MANAGEMENT PLAN	J. White	C. Grant	C. Grant	March 13, 2020
R1	DRAFT EMP WITH UPDATED DESIGN DRAWINGS	J. White	C. Grant	S. Rooke	March 3, 2021

Limitations of Report

The Environmental Management Plan (EMP) was prepared for the exclusive use of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRORD), its assignees and representatives, and is intended to outline environmental requirements, standard protocols and mitigation measures for the stream crossing replacement at Km 7.5 on the Morice Forest Service Road (FSR).

In developing this EMP, Profor Resource Development Inc. (Profor) has relied in good faith on information provided by MFLNRORD. Profor accepts no responsibility for any deficiency or inaccuracy contained in this report as a result of our reliance on the aforementioned information.

The guidance and findings documented in this report have been prepared for the specific application to this project. This EMP has been developed in a manner consistent with the level of care normally exercised by environmental professionals currently practicing under similar conditions in BC.

The EMP may be revised at the request of MFLNRORD should new information be discovered in future work from other investigations.

EXECUTIVE SUMMARY

The crossing replacement at Peacock Creek will have a net benefit to fish passage as the current culvert is a barrier to fish passage. The existing culvert has been in place since 1979 with a concrete spillway and side channel added in the 1990s to support fish passage. A review of the existing site conditions in 2019 found that the spillway and side channel may seasonally support fish passage at best.

Previous Peacock Creek stream reports noted the presence of Dolly Varden, rainbow trout and whitefish downstream of the crossing, although numerous other species have been documented in the Morice River which is a relatively short distance downstream of this site. Dolly Varden is the only fish species documented above the stream crossing.

A new bridge crossing is planned for this site, which will fully restore unrestricted fish passage. Managing the water will be key during construction to ensure no sediment-laden water enters the creek. The main areas of particular environmental concern to be aware of during planning and construction include:

1. Water management during construction – the stream must be diverted, a fish salvage completed and flow maintained downstream at all times.
2. There is no reduced risk instream timing window with this stream; work should be timed for low flows and low precipitation (July – September).
3. Stream channel – consideration must be given to constructing the new channel to accommodate the elevation differential that exists from the inlet through to the outlet and plunge pool. The final stream gradient and stream bed substrate will need careful consideration in order to ensure long term channel stability and fish passage, and prevent scour of any substructure bridge components.

CONTENTS

APPENDICES

1 INTRODUCTION

Profor was retained by the MFLNRORD to prepare an EMP in support of the replacement of a 2.3 m high by 4.0 m wide corrugated steel pipe (CSP) with a two lane bridge at Km 7.5 on the Morice FSR (Structure R5-147) (Figure 1). The proposed new crossing structure consists of a permanent 24.384 m steel girder with concrete composite deck bridge. The bridge will be on driven steel piles.

Profor conducted a fish habitat assessment and prepared a report for Peacock Creek in the summer of 2019 that summarized the historical fisheries information of the creek, potential upstream barriers and overall fish habitat upstream and downstream of the CSP (Profor 2019). The CSP has been in place since 1979 with the addition of a concrete spillway and low flow channel in the 1990s. There was no information available on the effectiveness of the spillway and low flow channel, but it is assumed that fish have been able to successfully move upstream under ideal water flow conditions. At the time of the site visit in July, the low flow channel was dry and there was insufficient flow to support fish jumping the spillway. The report concluded that due to the high quality upstream fish habitat, size of stream and large amount of upstream fish habitat, this crossing would be an ideal candidate for fish passage improvements.

This EMP specifically addresses the environmental values of the site, construction considerations and best management practices to implement during the crossing replacement. Refer to the tender package for the engineering design drawings.

2 APPLICABLE LEGISLATION

This section outlines the federal and provincial legislation applicable to the project. All work must comply with the conditions of any regulatory agency approvals and permits obtained to proceed with construction activities, as well as MFLNRORD contract requirements.

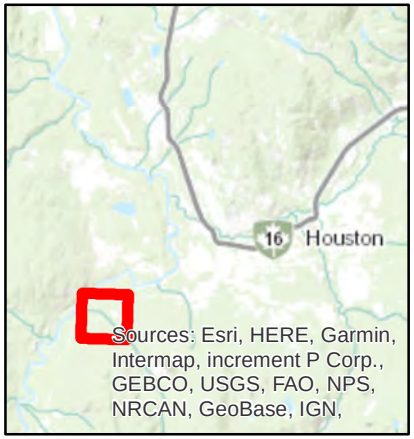
Applicable environmental protection legislation includes:

- Provincial Water Sustainability Act;
- Federal Fisheries Act;
- Provincial Heritage Conservation Act;
- Federal Migratory Birds Convention Act;
- Federal Species at Risk Act;
- Federal Transportation of Dangerous Goods Act;
- Provincial Spill Reporting Regulation; and
- Provincial Wildlife Act.

Figure 1. Peacock Creek Crossing Location Map

Legend

- Peacock Creek Crossing
- Streams
- Peacock Creek
- Roads
- Rivers and Lakes



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A referral to the Department of Fisheries and Oceans (DFO) will be required. The agencies may require additional environmental provisions beyond those listed in this EMP be incorporated into project approvals as a result of their working near water review process. Prior to conducting a fish salvage, a Scientific Fish collection permit from the Province and a license from DFO is required. Copies of this EMP and all approvals must be kept on-site for the duration of the project.

Additional resources and guides relevant to stream crossing replacement projects and instream works include:

- British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture (MOE 2017);
- Fish-stream Crossing Guidebook (MFLNRO et al. 2012);
- Freshwater Intake End-of-Pipe Fish Screen Guideline (DFO 1995);
- Best Management Practices for Amphibian and Reptile Salvages in British Columbia (MFLNRO 2016);
- Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia (MFLNRO 2013);
- Land Development Guidelines for the Protection of Aquatic Habitat (DFO 1993);
- Manual of Control of Erosion and Shallow Slope Movement (MOTH 1997);
- Projects Near Water — Measures to Protect Fish and Fish Habitat (DFO 2019);
- Skeena Region: Reduced Risk In-stream Work Windows and Measures (MWLAP 2005); and
- Standards and Best Practices for Instream Works: A Users' Guide to Working In and Around Water (MWLAP 2004a, updated 2009).

3 ENVIRONMENTAL DESCRIPTION

As noted previously, a fish habitat assessment was completed in July of 2019. A summary of the findings from that report is provided below. Site photos are found in Appendix B.

3.1 FISHERIES VALUES

Peacock Creek (Watershed Code 460-600600-07100) is a third order stream that is over 14 km long and drains the east side of Morice Mountain towards the Morice River. The existing CSP is located approximately 1.2 km upstream from the confluence of the Morice River.

The provincial fisheries data base Habitat Wizard had no fisheries information for Peacock Creek (Province of BC 2019). A report was found from 1975 where Dolly Varden (*Salvelinus malma*) were found upstream of the previous "wood stave culvert" and rainbow trout (*Oncorhynchus mykiss*), Dolly Varden and mountain whitefish (*Prosopium willaimsoni*) below the culvert (Morris and Eccles 1975). A review of previous studies for the Morice River near Peacock Creek was conducted to determine what fish species have been documented in the general vicinity. Numerous studies have been completed on the Morice River, but the majority were completed 20-30 years ago. Documented fish species in the Morice River include bull trout (*S. confluentus*), chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), chum salmon (*O. keta*), cutthroat trout (*O. clarki*), Dolly Varden, lake trout

(*S. namaycush*), lamprey (*Lampetra* spp.), longnose dace (*Rhynichthys cataractae*), longnose sucker (*Catostomus catostomus*), mountain whitefish, northern pikeminnow (*Ptychocheilus oregonensis*), pink salmon (*O. gorbuscha*), pygmy whitefish (*P. coulteri*), rainbow trout (resident and steelhead), sculpin (*Cottus* spp.), and sockeye salmon (*O. nerka*) (Province of BC 2019). The mainstem of the Morice River and many of the tributaries are used for spawning, rearing and refuge habitat by all of the salmonids (Jessop 2001). The online mapping tool Habitat Wizard showed pink salmon, rainbow trout, Dolly Varden, bull trout, coho salmon and cutthroat trout caught within a couple kilometers upstream and downstream of the Morice River - Peacock Creek confluence (Province of BC 2019).

Profor conducted a fish habitat assessment 200 m upstream and 200 m downstream of the CSP in July of 2019. Overall, fish habitat was considered good both upstream and downstream, particularly for rearing. Spawning habitat was considered moderate upstream of the CSP although the potential spawning gravels were dry at the time of the site visit. The average channel width downstream of the CSP was 8 m and the gradient was between 3-5%. The channel had riffle-pool habitat with cobbles (75%) as the dominant substrate material, followed by boulders (15%) and gravels (9%). The channel upstream of the CSP was 9-12 m wide and had a gradient of 3-5%. The upstream channel had riffle-pool morphology and was dominated by cobbles (60%), followed by gravels (20%) and boulders (5%).

3.2 WILDLIFE VALUES

Based on a search of the BC Species and Ecosystem Explorer (BC Conservation Data Centre 2020) for the Nadina Forest District and the habitat values noted on site, there is the potential for Olive-sided Flycatcher (*Contopus cooperi*), and grizzly bear (*Ursus arctos*) to be in the general area. Avoiding clearing during the bird nesting period (Section 6.1.2) or completing a nest survey prior to clearing will reduce the risk to Olive-sided Flycatchers. Proper site management, particularly of garbage and fuel storage, should minimize the risk of attracting grizzly bears or other animals to the site.

4 POTENTIAL ENVIRONMENTAL IMPACTS

A review of the project was undertaken to identify potential environmental impacts and mitigation measures associated with the stream crossing replacement. The construction activities that are likely to have an impact on environmental values are:

- Installation of a temporary access road and crossing;
- Site isolation and water management during construction;
- Vegetation clearing;
- Removal of the existing culvert, spillway, and associated fill material;
- Placement and activation of the stream channel; and
- Installation of new bridge and rip rap.

These works were then compared to DFO's Measures to Protect Fish and Fish Habitat for determination of potential impacts to habitat (Table 1). We determined the risk for all pathways to be low to moderate, and mitigable.

Table 1: Potential Environmental Impacts

Impact	Risk Assessment	Mitigation
Prevent the death of fish	LOW	Work in the dry, during low water, conduct a fish salvage; isolate the stream.
Maintaining riparian vegetation	LOW	Minimize amount of vegetation clearing required to access the site, revegetate as soon as possible after construction is complete.
Carry out works, undertakings and activities on land	LOW	Equipment will work from the stream bank as much as possible and in the dry for construction of the new stream channel.
Maintain fish passage	LOW	Construct a diversion channel to maintain fish passage during construction if possible. The new crossing will restore fish passage.
Ensure proper sediment control	LOW to MODERATE	Work will be performed in the dry. Erosion and sediment control measures should be implemented until the site is stabilized.
Prevent entry of deleterious substances in water	LOW	Equipment should be clean before entering worksite and monitored for leaks by the onsite Environmental Monitor (EM). Spill kits and containment equipment will be onsite at all times.

5 BEST MANAGEMENT PRACTICES FOR CONSTRUCTION

The following is a list of general best management practices that should be implemented to reduce the potential for harm to the environment during construction works. Measures specific to erosion and sediment control are detailed in Section 7.

- Before any work commences, a pre-work meeting should be held with all personnel to review the EMP and regulatory requirements (if any), ensure all necessary erosion and sediment control supplies are available, and that everyone has an understanding of procedures in case of spills.
- Equipment working on this project should be clean and free of leaks. It is preferable that machines working near the wetted area of the streams use biodegradable hydraulic fluids. Spill kits will be available on-site.
- Efforts should be made to fall any tree that must be removed away from the channel. If that is not possible, the tree should be lifted out and not dragged to protect undisturbed vegetation and the stream channel. Where possible, root systems should be left intact to provide soil stability.

- Rip rap should be clean and free of debris. Riprap must be non-acid generating or metal leaching. Rip rap should be placed using an excavator with a thumb and not end-dumped.
- The construction site should be kept tidy and any garbage removed daily to appropriate facilities daily to prevent attracting wildlife to the work areas or litter entering the water.

6 CONSTRUCTION CONSIDERATIONS

The following sections provides recommendations to minimize environmental risk during construction.

6.1 TIMING WINDOW

Based on the fish species present, there is no reduced risk instream works window for Peacock Creek. Timing should be planned for low flow and low precipitation levels, typically between July and September. The stream should be checked prior to starting work to ensure there are no spawning fish observed in the vicinity of the construction area.

Minor vegetation clearing will be required to install the temporary bridge and replace the crossing. If vegetation clearing is planned within the breeding bird window of May 1 to August 15th, a Qualified Environmental Professional (QEP) should be retained to ensure there are no active nests within or near the work area prior to clearing.

6.2 SITE ACCESS

Peacock Creek is located on the Morice FSR, a main resource road which services industrial, recreational, as well as local community traffic. The road must remain open for the duration of construction. The design drawings in the tender package includes a temporary road and bridge structure to be located upstream of the existing crossing.

Where possible, the construction contractor should minimize the amount of grubbing adjacent to the stream banks for placement of a temporary crossing to reduce the overall site disturbance. Placing the ends of a temporary bridge on mats or fabric can help protect the channel banks. Temporary erosion and sediment control measures for the detour route may be required to prevent sediment from entering the stream. Any material placed for the temporary crossing must be removed as soon as possible after the temporary bridge is removed and the site is to be restored.

6.3 CONSTRUCTION SEQUENCING

For instream works, the following sequence is anticipated:

- Establish the temporary road and bridge;
- Install stop nets and conduct fish salvage by qualified staff;

- Implement stream diversion; depending on the diversion method implemented, the stop nets may be removed at this stage at the discretion of the EM;
- Remove the road fill material, concrete spillway and the existing CSP;
- Construct the new stream channel and install the riprap prescribed in the engineered drawings;
- Direct a small amount of water over the new channel to "wash" the substrate; and this water is to be pumped to a vegetated area until the water is flowing clear;
- Return full flow to the channel and remove the stop nets (if not previously removed);
- Install the new bridge structure;
- Remove the detour and deactivate the detour road; and
- Seed all disturbed areas, including the detour route, using an appropriate weed-free seed mix and additional erosion and sediment control measures are to be installed as required.

6.4 FISHERIES SALVAGE AND STREAM ISOLATION

6.4.1 Fisheries Salvage

In order to remove the existing CSP and install the new bridge, a fisheries salvage must be completed, the site must be isolated, and the water diverted around the construction site prior to starting construction. Stops nets must be installed by the EM upstream and downstream, outside of the construction zone. Once the nets are in place, a fisheries salvage by qualified staff is required to remove all fish from the isolated stream. The salvage may be done using an electrofisher, minnow traps, dip nets and/or seine nets. It is expected that several passes will be required due to the large size of the stream. Once the EM is satisfied that all fish have been removed from the site, the stream diversion can be initiated. The EM should continue to monitor the construction site once the stream diversion is in place to remove any fish that may have been missed during the salvage. This will be particularly important in the plunge pool area which will be difficult to salvage until the water levels are lowered.

6.4.2 Stream Diversion

It is recommended that a stream diversion is set up rather than pumping the water around the construction site due to the volume of water and the amount of time likely required to remove the culvert and spillway, and construct the new stream channel. It is our understanding that the pipes used to divert the stream when the spillway was constructed over 20 years ago may still be in place in the road approach fills, but the condition of the pipes is unknown. Diversion pipe(s) should be sized to meet the anticipated water volume with contingency in case of precipitation. Scour protection will be required at the outlet of the diversion pipe where it reconnects with the stream.

Alternatively, a diversion channel could be excavated from the inlet side, down to a suitable location downstream of the construction area. Consideration must be given to the location of the temporary channel as equipment and vehicles will not be able to cross without a temporary bridge. The excavated channel should be wide and deep enough to accommodate the anticipated flows, including precipitation events. Scour protection and/or energy

dissipators may be required at the downstream end of the diversion and the diversion should end where it will not backwater the construction site. Once construction is complete and water is returned to the new channel, the temporary channel should be reclaimed to match the natural ground.

A combination of a diversion pipe and a temporary excavated channel can be considered for diverting the flow during construction. Regardless of which method is used, stream flow must be maintained downstream at all times. Once the stream is diverted, removal of the CSP and installation of the new stream channel can commence.

6.4.3 Sump

Regardless of the method chosen to isolate the stream, one or more sumps will be needed to manage any sediment-laden water generated within the construction site. A sump on the upstream end could be used to prevent water from entering the excavation area. A sump may also be required downstream, depending on the amount of seepage encountered during excavation.

Turbid water collected in the sumps will need to be discharged from the worksite to a designated disposal site, such as a well vegetated area, that will allow it to settle out before entering back into the stream. The EM should approve the location for the sumps and discharge locations and monitor the discharge regularly to ensure turbid water is not flowing back to the stream.

6.5 STREAM CHANNEL CONSTRUCTION

The new stream channel should be constructed to tie into the width and depth of the existing channel, measured at approximately 10 m wide and 0.75 m deep. The channel upstream and downstream of the CSP had an average gradient of 3-5%. The grade through the culvert was estimated at 2%. There was a large gradient difference across the spillway (spillway has a 2.3 m vertical drop over 3.5 m horizontal distance) and plunge pool that will have to be overcome to allow fish access and long term channel stability. The gradient of the new channel should be averaged across the entire length of the CSP, spillway, outlet pool and 10-15 m upstream and downstream of the CSP to avoid any sudden drops. The maximum recommended gradient would be to match the natural stream gradient of approximately 5%. If the gradient is steeper, four to five weirs comprised of larger cobbles, boulders and/or small pieces of rip rap should be considered to break up the channel and slow the water flow. The streambed material should closely match the size of the existing channel, consisting of 60-70% cobble, 20% gravel and 10% boulders (or rip rap). The boulders should be partially buried to increase channel stability. A small amount of fines is okay to help seal the channel.

Once the new channel is established, a small amount of water should be introduced into the channel and pumped to a vegetated area until the water runs clear. This will reduce the initial flush of turbid water typically experienced when passing water over a new channel. After the water has run clear and with approval from the EM, the stream may be diverted back to the new channel by blocking the diversion. If water is flowing through the site to the satisfaction of the EM, the stop nets can be removed.

It is expected that the new channel will take time to stabilize and may experience bed load movement and/or downcutting, particularly after freshet. It is recommended the channel be monitored for the next few years to ensure it is stable and allows for fish passage.

7 EROSION AND SEDIMENT CONTROL MEASURES

Stream crossing replacements have the potential to cause erosion and/or sedimentation to the streams. General measures applicable to this project include:

- Implement sediment and erosion control measures prior to construction and as soon as needed to reduce the potential for negative impacts to the surrounding environment;
- A stockpile of erosion and sediment control materials should be available at all times. This includes but is not limited to silt fencing, filter fabric, sand bags, water pumps, heavy duty plastic or tarps, and straw bales;
- Any sediment-laden water should be directed to a suitable location where sediment can filter out prior to water re-entering the stream;
- Any exposed soil should be seeded with an invasive-free seed mix and mulched with straw as soon as possible to prevent erosion;
- Any stockpiled erodible material should be located on flat stable ground at least 15 m from the stream with appropriate erosion control to prevent sediment being transported to the stream;
- Minimize ground disturbance to only those areas required for construction. Vehicles and equipment will be restricted to designated work areas and prescribed access routes;
- Temporarily delay work if high precipitation levels could result in erosion;
- Track pack fill perpendicular to the fill slope or roughen soils to slow water and promote sites for seed growth; and
- Ensure any erosion and sediment control measures are removed and properly disposed of when no longer required.

Examples of typical ESC measures and installation guides are provided in Appendix C.

8 ENVIRONMENTAL MONITORING

An EM with experience in stream diversions should be on-site during construction, particularly for the higher risk activities. The high-risk activities include, but are not limited to:

- Installation of a temporary access and stream crossing;
- Site isolation and fish salvage;
- Removal of existing culvert, spillway and fill;
- Stream channel construction;

- Returning the flow to the channel; and
- Oversee installation of ESC measures.

As part of routine inspections, the EM should check equipment for leaks or spills and monitor the fuel storage and handling practices.

The EM should monitor water quality during construction works, particularly during the stream diversion, to ensure water quality objectives are being met. A monitoring site should be established upstream and downstream of the construction site. The frequency of water sampling will be dependent upon the activities on-site as well as weather conditions. Sampling can be conducted with a field level accuracy turbidity meter and pH meters (if uncured concrete products are being used). Table 2 summarizes the applicable BC Water Quality objectives for aquatic life (Ministry of Environment 2016).

Table 2: Summary of BC Water Quality Objectives.

Parameter	Maximum Allowable Level
Suspended Solids	Change from background of: • 25 mg/L at any one time for a duration of 24 h in all waters during clear flows or in clear waters • 5 mg/L at any one time for a duration of 30 d in all waters during clear flows or in clear waters • 10 mg/L at any time when background is 25 - 100 mg/L during high flows or in turbid waters • 10% when background is >100 mg/L at any time during high flows or in turbid waters
Turbidity	Change from background of: • NTU at any one time for a duration of 24 h in all waters during clear flows or in clear waters • 2 NTU at any one time for a duration of 30 d in all waters during clear flows or in clear waters • 5 NTU at any time when background is 8 - 50 NTU during high flows or in turbid waters • 10% when background is >50 NTU at any time during high flows or in turbid waters
pH	6.5-8.0 (or the same as receiving waters/background conditions)
Oil and Grease	The surface of the water should be virtually free of petroleum, animal or vegetable oils

The EM may direct erosion and sediment control measures to reduce the risk of sediment entering the water. The EM should record all activities, including any site-specific ESC measures implemented. An example EM report has been provided in Appendix D.

9 FUEL HANDLING AND SPILL CONTINGENCY

9.1 FUEL HANDLING AND STORAGE

The following is a list of general best management practices associated with refueling and the storage of fuel for construction works to minimize the risk of spills. Fuel management should follow the guidelines outlined in the Province's *A Field Guide to Fuel Handling, Transportation and Storage* (WLAP 2002).

- Fuel or other hydrocarbon containers should not be stored within 30 m of the stream.

- Spill kits should be available at all refuelling areas, and on heavy equipment to allow immediate response to spills. All onsite staff should be trained in refuelling practices, handling requirements, spill kit locations and spill response.
- If possible, all vehicles and machinery will be re-fuelled a minimum 30 m away from the water. Fuel must be properly stored within tidy-tanks or in approved secondary containment facilities, following Transportation of Dangerous Goods requirements.
- Small fuel tanks and containers must be stored within containment areas or spill trays capable of containing 110% of the volume of the liquid.
- Pumps, generators or other small equipment will be placed on a spill tray when working near water.

9.2 SPILL RESPONSE AND REPORTING

A spill response and reporting procedure should be implemented prior to the commencement of work. An example is provided in Appendix E. Spills should be reported to the Ministry Representative and EM as soon as possible. Any spill entering a waterbody must be reported to Emergency Management BC (EMBC) at 1-800-663-3456. Spills of fuels onto land greater than 100 L in volume must also be reported to EMBC.

Small fuel or oil leaks are the most common spills encountered on construction sites of this nature. Any contaminated material and surrounding soil as well as any sorbent material used for clean-up must be removed and placed in a designated container for proper disposal.

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APPENDIX A – SITE PHOTOS

Photo 1. Peacock Creek CSP outlet and spillway.

Photo 2. Culvert inlet and concrete headwall at Peacock Creek.

Photo 3. Typical channel, upstream of the culvert, looking upstream.

Photo 4. Stream channel downstream of the culvert outlet, looking downstream.

Photo 5. Looking downstream from the spillway towards the plunge pool.

Photo 6. View through the culvert, looking from the outlet towards the inlet.

APPENDIX B – EXAMPLE EROSION AND SEDIMENT CONTROL MEASURES

Source: Site C Clean Energy Project Water Management, Erosion and Sediment Control Plan (rev 1) (Klohn Crippen Berger Ltd. and SNC-Lavalin Inc. 2016)

BMP 1	SURFACE GRADING, ROUGHENING & SLOPE TEXTURING	Stripping, Grading and Site Preparation

Description and Purpose

Note: The practices outlined in this BMP are not stand-alone measures; they should be used in conjunction with other erosion and sediment control practices.

- **Stripping & grading to Final Stabilization**
- **Slopes**
- **Stockpiles**

Texturing exposed slopes and stripped/graded areas by roughening the soil surface or installing tracks, grooves, furrows or benches that conform to contours helps interrupt the movement of sheet run-off across exposed areas, reducing effective slope lengths and decreasing potential for sheet and rill erosion. Roughening of exposed soils and tracking/grooving/furrowing perpendicular to the prevailing wind can also significantly reduce the detachment and creep/saltation of soil particles by wind.

Applications and Advantages

- These measures are suitable for all compacted stripped/graded areas and all disturbed areas, especially slopes 3H:1V or steeper (on fresh cut of fill slopes to a maximum gradient of 2H:1V)
- Surface roughening and slope texturing are temporary erosion control measures that need to be used in conjunction with erosion control BMPs. Surface roughening provides some instant erosion protection for exposed soils prior to final stabilization with vegetation or other cover
- Texturing will create pockets to entrap coarse sediment, reducing the sediment yield down-slope.
- Good suitability for freshly cut or filled slopes (at least 8 m in length) with a maximum slope of 2H:1V, with reasonably cohesive soils
- Benching/terracing can be used to reduce the effective length of long slopes (break up slopes)
- Decreasing run-off velocity and surface wind speed decreases erosion potential
- Increases infiltration of run-off into the soil
- Traps and retains seed detached by water and/or wind
- Provides beneficial 'seedling-safe' sites for germination/establishment of seedlings
- Enhances the performance of topsoiling, mulching and hydroseeding

Limitations

- Generally impractical for short slopes with insufficient room for machinery to maneuver
- Generally not suitable for excessively steep slopes and/or non-cohesive soils
- May cause water build-up and sloughing in wet/seepage areas (obtain geotechnical advice)
- These practices provide limited, short-term benefit and work best when used as part of a system of practices/controls
- Grading costs may be increased

Installation

- Do not run heavy equipment on excessively wet soils as this will increase compaction

Surface Roughening/Furrowing

- Always leave exposed soils in a rough-graded condition; do not smooth grade soil
- On large, relatively flat stripped and graded areas, reduce wind erosion potential by furrowing or ripping the soil perpendicular to the prevailing wind direction (using the ripper teeth on a grader is very effective; depth should be 0.15 to 0.30 m). When furrowing sloped areas, ensure that the furrows run perpendicular to the fall of the slope

Surface Tracking (also known as cat-tracking or track-walking)

- Use tracked construction equipment to move up and down the slope, leaving depressions perpendicular to the slope direction. Limit machine-tracking to one or two passes to prevent excessive compaction
- Avoid this practice on excessively wet or clayey soils
- Tracked depressions in the soil will decrease run-off velocities, trap sediment, improve seedling development and increase infiltration of water
- For topsoiling and surface tracking, be sure to immediately seed and mulch roughened areas to obtain optimum seed germination and seedling growth. Establish good soil and seed contact

Inspection and Maintenance

- Inspect a minimum of once every seven (7) days and during or within 24 hours of rapid snowmelt, rainfall events of 12 mm or greater in a 24 hour period, or rainfall on saturated soils
- Areas damaged by rilling or erosion should be re-graded and re-seeded

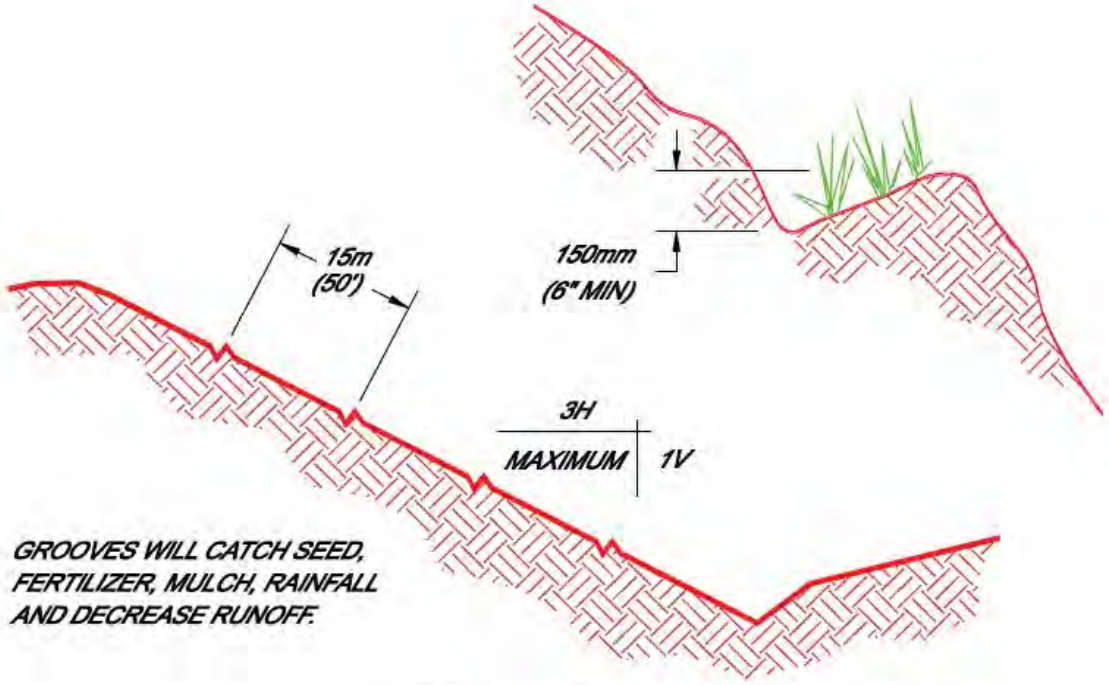
Construction Details

Refer to the following figures:

Surface Roughening

'TRACKING' WITH MACHINERY UP AND DOWN THE SLOPE PROVIDES GROOVES THAT WILL CATCH SEED, RAINFALL AND REDUCE RUNOFF.

TRACKING



GROOVES WILL CATCH SEED, FERTILIZER, MULCH, RAINFALL AND DECREASE RUNOFF.

CONTOUR FURROWS

THE CITY OF CALGARY
WATER SERVICES

Surface Roughening

Erosion & Sediment Control Guidelines 2011

Source: Salix Applied Earthcare - Erosion Draw 5.0

FILE: srfrough.dgn

BMP 2	SEEDING	Erosion Control

Description and Purpose

The planting or placing of seed on disturbed soil after disturbed areas have been topsoiled or otherwise prepared for seeding. Seeding can provide both temporary and permanent cover and root structure to provide effective erosion control.

- **Temporary or Permanent Measure**
- **Use from Stripping and Grading to Final Site Stabilization**
- **Slopes, Stockpiles (Seeding), Borrow Areas, Landscaping**

Applications and Advantages

- Temporary seeding is used on suitable interim areas that are disturbed and require temporary protection. Temporary seeding is encouraged whenever possible to help reduce erosion on construction sites. Temporary seeding is an important component of "phased" construction activities.
- Common areas for temporary seeding include topsoil stockpiles, rough graded areas, berms and other temporary earthen structures.
- Establishing vegetation cover on exposed soils helps protect soil from erosion by raindrop impact, increases infiltration and reduces run-off. after establishment, temporary seeding can reduce sheet erosion by approximately 90% compared to exposed soil conditions (usda, scs, 1976).
- Temporary seeding can reduce maintenance costs for other site controls (i.e. sediment basin maintenance (clean-out) can be significantly reduced if temporary vegetative cover is established in the contributing drainage area). Temporary vegetation cover is also essential to protecting the integrity of other earthen structures used to control sediment (i.e. diversion and containment berms, compost berms).
- Seeding disturbed areas with a suitable mixture of grasses and forbs provides an inexpensive method of stabilizing soils.

Limitations

- Establishing vegetation cover with temporary seeding can be difficult in northern climates (dry, cool, short growing season). Seasonal planting windows may not coincide with the construction schedule.
- Establishing vegetation cover on steep slopes may require additional - and sometimes expensive - measures such as compost blankets, RECPs or hydromulching.
- Vegetation may require regular maintenance, especially adjacent to roadways.
- Reseeding and amendments may be required where there is poor vegetation establishment.
- Reseeding is not appropriate for areas impacted by construction activities/traffic.

Site Preparation

- For permanent seeding, confirm areas to be seeded will be dormant for one year or more or are at final contour and are ready for permanent seeding.
- Ensure concentrated run-off is being diverted away from all exposed slopes and areas to be seeded.
- Conduct soil tests to determine pH and nutrient content, then determine requirements for suitable soil amendments.
- For soil that is compacted, crusted or hardened, the soil should be loosened (with discing, raking or harrowing) and machine-tracked (refer to BMP…, Surface Roughening). Hydraulic planting generally requires less seedbed preparation (generally suited to slopes steeper than 2H:1V, where seedbed preparation is difficult).
- Seed to soil contact is the key to good germination. Prior to permanent seeding, prepare firm (but not compact) seedbed, 75 - 125 mm deep, with at least 75 - 100 mm topsoil depth (or as otherwise specified). The seedbed should be free of large clods and large stones. The prepared surface should be in reasonably close conformity to the lines, grades and cross sections shown on the grading drawings.

Seeding/Amendments

- Use certified Canada No. 1 seed, free of disease, weed seeds or other foreign materials, and meeting the requirements of the Seeds Act.
- Seed to soil contact is the essential for good germination.
- Apply seed immediately after seedbed preparation while the soil is loose and moist. If the seedbed has been idle long enough for the soil to become compact, the topsoil should be harrowed/loosened.
- Always apply seed before applying mulch.
- Uniformly apply seed at the rates specified in the landscaping or erosion control plan.
-

BMP 3	MULCHING	Erosion Control

Description and Purpose

- **Erosion Control Mulches are a Temporary Measure**
- **Use on Slopes, Stockpiles and Other Exposed Soils from Clearing and Grubbing to Final Stabilization**

Mulching is the application of a protective layer of straw/other suitable material to exposed soil surfaces. Straw mulching and/or hydromulching is also used in conjunction with seeding and hydroseeding of critical areas to provide temporary erosion control and promote the establishment of vegetation. Mulching with straw or fiber mulches is also commonly used as a temporary measure to protect bare or disturbed soil areas that have not been seeded. In addition to absorbing raindrop impact and reducing soil erosion, suitable mulches can also help conserve soil moisture, moderate soil temperature, increase infiltration and protect seeds from predators, run-off and wind.

Mulches can be classified as “dry” (i.e. straw, compost, wood chips, RECPs, rock) and “wet” (i.e. wood fibre and paper slurry applied by hydraulic equipment). Straw mulching consists of placing a uniform layer of straw and binding it onto the soil with suitable devices. Hydraulic mulching typically consists of applying (using hydromulching equipment) a matrix of shredded wood fibre (or other suitable fibre), emulsifying agent and tackifier.

Applications and Advantages

- There are a large variety of mulches available for application on a range of slopes and soil types.
- Mulch application provides a relatively low-cost method of controlling erosion and/or promoting plant growth.
- Mulching is most commonly used to provide temporary stabilization of soil, usually until permanent stabilizing vegetation is established.
- On steep slopes, greater than 2.5H:1V, or where the mulch is susceptible to movement (by wind or water), consider hydraulic mulch application, application of a tackifier on the mulch or mechanical anchoring (i.e. straw crimping).
- To promote vegetation development and provide temporary erosion control, mulches can be applied after seeding (or, in the case of hydroseeding; during seeding). Where mulches are used to compliment vegetation establishment, they should be designed to last as long as it takes to establish effective vegetative cover for erosion control.
- Straw mulch is suitable for application to disturbed areas requiring temporary erosion control. Straw mulch is suitable on slopes where moderate rill erosion may occur. Straw mulch can be used in combination with temporary and/or permanent seeding strategies to enhance plant establishment.

- Hydraulic mulch is suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established, and disturbed areas that will be redisturbed following an extended period of inactivity.

Limitations

- Mulches should be anchored on steep slopes (2.5H:1V or steeper) and/or where they are susceptible to movement by wind/water.
- Punching/crimping of straw may be difficult in sandy soils.
- Certain mulches may be unavailable or too expensive in some areas.
- Cost-effectiveness of mulching large areas can decrease if mulching by hand.
- Long-term erosion control may not occur if the mulch does not provide the required protection time for the establishment of long-term vegetation cover.
- Some mulches (i.e. wood chips, rock cover) may prevent (or slow) vegetation establishment.
- Organic mulches are not suitable for application if delivered in a wet or moldy state.
- Some organic mulches may contain weed seed (i.e. hay) and unwanted plant material.

Implementation

Where feasible/desirable, suitable vegetation should be shredded during clearing activities, providing a local supply of mulch (economical, plus it may provide a reservoir of local seeds).

Site Preparation

- Fine-grade the area of exposed soil.
- Remove large rocks, clods and debris that may prevent contact of the mulch with the soil surface.
- When seeding, follow the guidance in BMP 12 (Seeding).

Mulch Installation

Straw Mulching:

- The length and bulk of cereal straw makes it an excellent mulching product (reduces raindrop impact and moderates soil surface microclimate).
- Straw is weed free, light and readily available in small and large bales.
- Hay should not be used as mulch (contains weed seeds and may attract wildlife).
- For seeded sites, apply 3,500 – 4.500 kg/ha, aiming for 80% cover.
- For unseeded sites, mulch at 4,500 – 6,500 kg/ha, aiming for 90% cover.
- A standard square bale (about 35 kg) covers approx. 90 m^2.
- For this practice to be effective, care should be taken to ensure that straw mulch is in close contact with the soil (rather than just providing cover).
- Straw mulch can be applied by hand or using a straw blower (can blow straw 50 – 80 feet).
- Straw placed on exposed areas and on slopes steeper than 2.5H:1V should be anchored.

BMP 4	SILT FENCE	Sediment Control

Note: Silt fence is a **sediment control practice** (occasionally used as a temporary diversion structure) intended to supplement appropriate upstream run-off and erosion controls.

Definition and Purpose

- **All stages of construction**
- **Perimeter control for stockpiles, slopes and site perimeters**

- Silt fence is a permeable geotextile barrier installed vertically on support posts and entrenched in the ground. Silt fence is installed along contours and in "smile" and "J-hook" patterns designed to detain sediment-laden sheet flow from small, disturbed areas.
- Properly designed, installed sections of silt fence can capture sand and coarse silt-size particles (while silt fence may provide some limited filtering of sediment-laden water, it is most effective at providing temporary detention of sediment-laden run-off, allowing settling of coarse sediment).
- In combination with upstream erosion and run-off controls, silt fence can be an effective way to capture and settle coarse sediment from small areas subject to sheet flow.
- Silt fences generally have a useful life of one up to season (dependent on the amount of maintenance required).

Applications and Advantages

- Silt fence is only suitable for detaining sediment-laden flow from locations generating low volume overland sheet flows.
- Silt fence is most effective for trapping larger particle sizes (coarse silt to sand): Finer-size material (fine silt and clay- size) is not detained.
- Silt fence is a suitable practice for the toe of short, exposed cut and fill slopes, as a contour boundary between a construction site and other critical areas such as environmentally sensitive areas and as a stockpile perimeter control.

Limitations

- Improperly applied or installed silt fence can increase erosion.
- Failure to properly plan, install, inspect and maintain silt fence can result in major sediment releases.
- Silt fence is a temporary sediment control practice, requiring a high degree of inspection and maintenance. As a temporary practice, silt fence should be removed when the contributing area is stabilized.
- Silt fence should be considered, wherever possible, as a "last line of defence". There is no substitute for controlling upstream run-off and erosion.
- Long, continuous runs of fence concentrate run-off and commonly lead to failures.
- Do not install silt fence at locations where concentrated run-off occurs or may occur. Silt fences are not designed to withstand high heads of water. Concentrated flows rapidly undercut silt fence or knock it over, a common cause of fence failure and a major cause of off-site sediment releases.
- Silt fence is not effective unless properly sliced or entrenched and compacted into the ground.
- Silt fence should not be designed to impound sediment or water more than 0.5 m high.

- Silt fence does a poor job of controlling clay and fine silt in sediment-laden run-off: Run-off is usually not detained long enough to allow settling of fine soil particles (designers should consider site soils and include appropriate source and detention controls to prevent releases of sediment off- ite). Clays and fine-silts can have extremely deleterious impacts on receiving water-courses and off-site areas.
- Do not place silt fence on a slope. Unless intended as a diversion, long runs of silt fence that do not follow a contour can cause diversion of run-off, resulting in washouts at low spots.

Implementation

- Clean run-off should be diverted away from sediment containment controls such as silt fence.
- Always determine how run-off volume is going to exit. Contributing drainage area (followed by soil type) is the primary consideration when determining silt fence suitability, location and quantity.
- Maximum sedimentation behind the fence should not exceed half the fence height or 0.3 m.
- Silt fences are not to be constructed in areas where flow velocity is expected to exceed 0.03 m/sec.
- Steel posts (minimum 2 kg/m with projections for fastening fence), driven 600 mm into the ground are recommended. Wood posts (100 mm in diameter, with a minimum length of 1.35 m) are an alternative, but may be difficult to drive 600 mm into the ground or may not be reusable.
- Adequate post spacing and proper entrenchment of fence are the two most critical installation requirements.

Location Requirements:

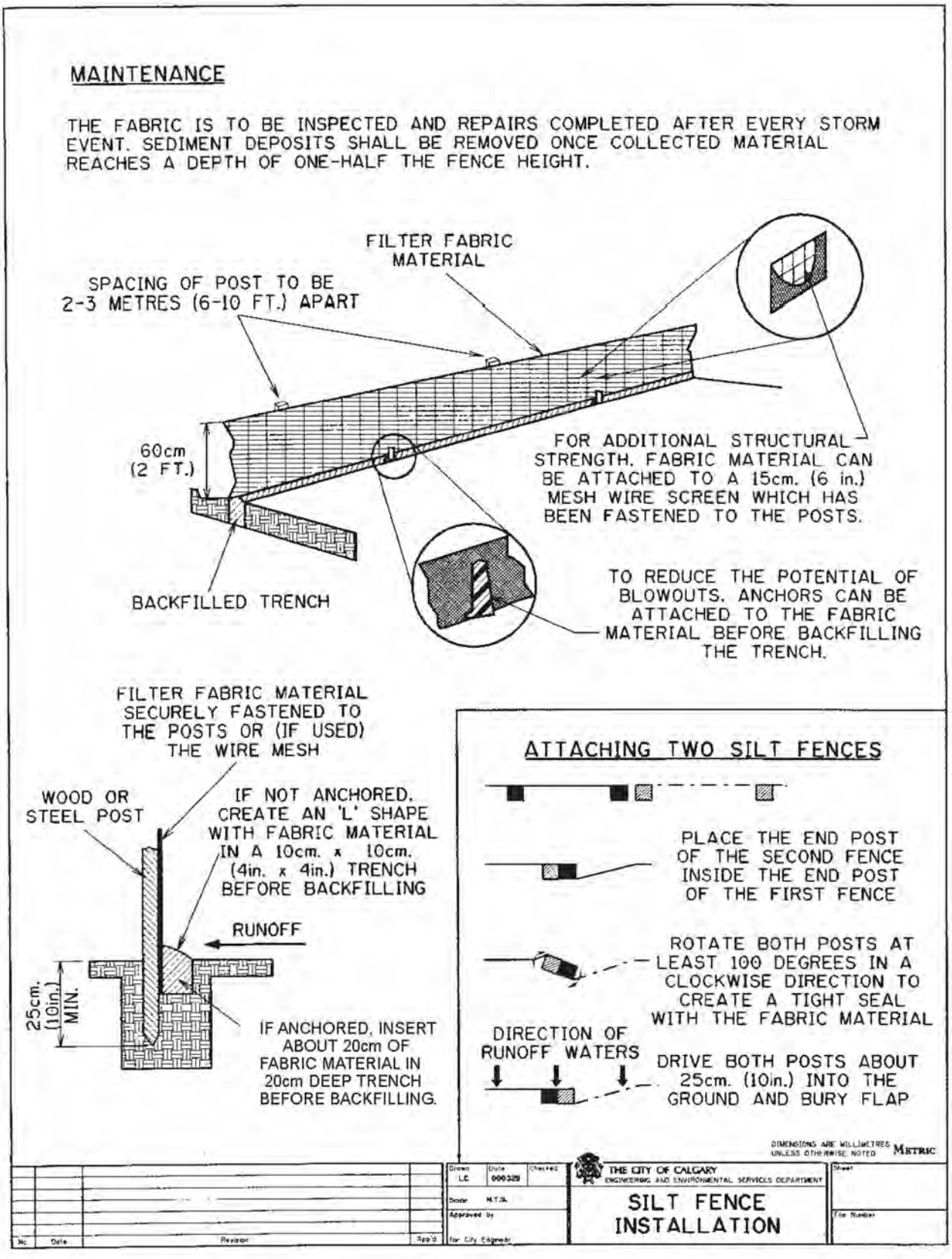
- Contributing drainage area should not exceed 0.1 ha per 30 m of fence.
- The run-off path length above a fence should not exceed 30 m.
- Maximum slope gradient upstream of a fence should not exceed 2H:1V.
- Unless intended as a temporary diversion structure, silt fence should be installed along a contour, with ends of the fence pointed upslope.
- Fence should be installed at least 2 m from the toe of a slope.
- Fence should not be used in drainage swales, except for very low volume swales (flow velocity < 0.03 m/sec) with grades not exceeding 2% and contributing areas not exceeding 0.8 ha.

Installation Requirements:

- Silt fence should be firmly entrenched and anchored into the soil.
- Fence height should not exceed 0.9 m. However, the ponding height of water should not exceed 0.5 m (install stabilized overflow sections on long runs of fence).
- Silt fence should be firmly attached to posts (steel T-posts or 100 mm (4”) diameter wood stakes), driven at least 600 mm into the ground on the downstream side of the fabric.
- Minimize joints by installing fence from a continuous roll. Where joints are required, construct at least a 0.4 m overlap and wrap the end posts together.
- Run-off detention requires storage space behind the fence. Fences constructed on a slope have considerably less retention capacity. Always install the fence at least 2 m from the toe of slopes.
- The maximum length of each run of silt fence should generally not exceed 40 m.

Inspection and Maintenance

- Inspect this sediment control practice a minimum of every seven days and after significant rainstorm/snowmelt events sufficient to cause surface run-off.
- Ensure silt fences are providing the required detention of run-off and sedimentation.
- Except where used as a temporary diversion, ensure silt fence is installed on contour (or in effective “smile” or “J-hook” configurations), with end sections of fence pointed upstream.
- Do not accept long, linear runs of silt fence installed without J-hooks or “smiles”.
- Check all sections of fence for adequate entrenchment by pulling firmly upwards on the fence (fence which moves is not adequately trenched/sliced and compacted).
- Check all sections of fence are firmly secured to posts. Ensure post spacing does not exceed 2 m.
- Ensure stabilized overflows are installed at least every 30 m on long runs of fence. Ponded water should not exceed 0.5 m depth.
- Remove accumulated sediment when it reaches 50% of impoundment height (i.e. 0.25 m).
- Replace damaged fabric and address flow-around and/or undermining problems immediately.
- Silt fence is a temporary sediment control practice: Remove and appropriately dispose of fence as soon as the contributing area is stabilized.



Traditional Trenching Method for Silt Fence Installation

APPENDIX C - EXAMPLE ENVIRONMENTAL MONITORING FORM

Environmental Monitoring Report

Date: _____

Project: _____

Environmental Monitor: _____

Client: _____

SITE CONDITIONS:

Weather: _____

Temperature: _____

Precipitation:_____

Summary of Activities and Instructions:

ESC Measures, notes and comments:

General Comments and Conversations:

Pictures:

APPENDIX D – SPILL RESPONSE PLAN

In the event of a spill, all workers shall immediately take the necessary steps to abate an uncontrolled discharge. The contractor will provide the necessary labor, equipment, materials and absorbents to contain and remove the spill, clean up the affected area, dispose of waste materials at an approved disposal site, as well as restore the area and take precautions against a similar incident occurring. If a spill of fuel, oils, lubricants or other harmful substances occurs, the following procedures will be implemented.

- Ensure Safety
    - Ensure personal/public, electrical and environmental safety.
    - Wear appropriate Personal Protective Equipment (PPE).
    - Never rush in, without understanding the product spilled before taking action.
    - Warn people in immediate vicinity.
    - Ensure that no ignition sources are present**,** if the spill is of a flammable material.
- Stop the Flow (When Possible)
    - Act quickly to reduce the risk of environmental impacts.
    - Close valves, shut off pumps or plug holes/leaks, set containers upright.
    - Stop the flow of the spill at its source.
- Secure the Area
    - Limit access to spill area.
    - Prevent unauthorized entry onto site.
- Contain the Spill
    - Block off and protect direct paths to water.
    - Prevent spilled material from entering the water.
    - Use spill sorbent material to contain spill.
    - If necessary, use a dike or any other method to prevent any discharge off site.
    - Make every effort to minimize contamination.
- Notify / Report
    - Report any spills to the Construction Supervisor and EM immediately.
    - If the spill meets the threshold for reportable levels (table below), EMBC will be contacted within 24 hours
- Clean-Up
    - Technical assistance is available from the EM on clean-up procedures and residue sampling.
    - All equipment and/or material used in clean-up (e.g. used sorbents, oil containment materials etc.) must be disposed of in accordance with BC Ministry of Environment requirements. The EM will assist in compliance with federal and provincial legislation.
    - Accidental spills may produce special wastes (e.g., material with > 3% oil) and contaminated soil. All waste disposal must comply with the BC Hazardous Waste Regulations and the BC *Environmental Management Act*.

- Waste-contaminated sorbent material may not be disposed of in a landfill without prior approval from MOE and the landfill operator.
- Contaminated soil must be treated and dealt with as required on a site-specific basis and must comply with the requirements of the BC Contaminated Sites Regulations.

REPORTABLE SPILL QUANTITIES

Substance	Quantity to Land	External Reporting
Flammable Gas (propane)	10kg or 10 mins	EMBC
Non-Flammable Gas (CO2)	10kg or 10 mins	EMBC
Flammable Liquids	100 L	EMBC
Corrosive Liquids (battery acid)	5kg or 5 L	EMBC
Environmental Hazards (ie PCBs)	1 kg or 1 L	EMBC
Oil and Waste Oil	Great than or equal 1 L	EMBC
Antifreeze	5L	EMBC
Any Spill to Water	Any amount	EMBC